

# Relative Leaching and Aquatic Toxicity of Pressure-Treated Wood Products Using Batch Leaching Tests

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Size-reduced samples of southern yellow pine dimensional lumber, each treated with one of five different waterborne chemical preservatives, were leached using 18-h batch leaching tests. The wood preservatives included chromated copper arsenate (CCA), alkaline copper quaternary, copper boron azole, copper citrate, and copper dimethylthiocarbamate. An unpreserved wood sample was tested as well. The batch leaching tests followed methodology prescribed in the U.S. Environmental Protection Agency toxicity characteristic leaching procedure (TCLP). The wood samples were first size-reduced and then leached using four different leaching solutions (synthetic landfill leachate, synthetic rainwater, deionized water, and synthetic seawater). CCA-treated wood leached greater concentrations of arsenic and copper relative to chromium, with copper leaching more with the TCLP and synthetic seawater. Copper leached at greater concentrations from the arsenic-free preservatives relative to CCA. Arsenic leached from CCA-treated wood at concentrations above the U.S. federal toxicity characteristic limit (5 mg/L). All of the arsenic-free alternatives displayed a greater degree of aquatic toxicity compared to CCA. Invertebrate and algal assays were more sensitive than Microtox. Examination of the relative leaching of the preservative compounds indicated that the arsenic-free preservatives were advantageous over CCA with respect to waste disposal and soil contamination issues but potentially posed a greater risk to aquatic ecosystems.

## Introduction

Manufactured wood products from many wood species (e.g., southern yellow pine, Douglas fir) require treatment with a preservative if they are to be used in environments where decay or rot is likely. Pressure treatment of wood refers to the process where wood is impregnated with preservatives under pressure (*1*). Wood preservatives primarily include

oilborne chemicals (creosote, pentachlorophenol) and waterborne chemicals. The main waterborne wood preservative used in North America in recent decades has been chromated copper arsenate (CCA). In 1996, CCA-preserved wood represented 79% of the U.S. wood preservative market (*2*). Environmental and health issues stemming from the chemicals in CCA-treated wood, primarily arsenic, have raised concerns over its use and disposal (*3–7*). The wood preservation industry and the U.S. Environmental Protection Agency (EPA) agreed to phase out the production of CCA-treated wood for many uses (predominantly residential) beginning in January 2004. Instead of producing CCA-treated wood for residential use, the wood-treatment industry has converted to alternative wood preservatives, a majority of which do not contain arsenic or chromium.

In this research, the relative leachability of preservative chemicals from CCA-treated wood and four different arsenic-free preservatives was examined. Basic descriptions of each wood preservative are provided in the online Supporting Information section available with the web version of this article. While a variety of leaching tests have been performed on CCA-treated wood (*8–13*), fewer leaching tests have been conducted on wood treated with alternatives to CCA (see Solo-Gabriele et al. (*14*) for a compilation of industry-reported data). Additionally, side-by-side comparisons of leaching characteristics of preservative-treated wood products are very limited. Because of differences in preservative leaching properties that result from varying wood types, treatment conditions, and leaching test methodologies, comparing leaching results from different studies can prove difficult. Eighteen-hour batch leaching tests were performed. Such tests are often one of the first steps conducted to evaluate the leachability and potential migration of chemicals from soils and wastes (*15*), and in some cases are directly incorporated into regulations.

The leached chemical concentrations from the treated wood products tested were used along with relevant regulatory limits and risk-based target concentrations to assess potential impacts on waste disposal systems (e.g., landfills) and soil underlying and surrounding treated wood structures. Batch leaching test results may also provide a preliminary estimate of the relative impact of leached chemicals from treated wood products used in aquatic applications (e.g., piers, docks, bulkheads). Chemical leaching data alone, however, may not always be reflective of true aquatic risks (*16*). Water quality standards are developed using assumptions regarding an element's form and bioavailability, assumptions that may not be valid in a given environment. The risk presented by a mixture of chemicals in solution may be different than for the individual species alone. Bioassays can provide added insight that chemical measurements alone do not provide. To further examine the potential relative impact of the different wood preservative systems on aquatic environments, three aquatic toxicity assays were conducted on the leachate samples. The relative leaching concentrations and aquatic toxicities reported here provide needed input for broader risk or life-cycle assessments involving an evaluation of different treated wood products.

## Materials and Methods

**Sample Preparation.** Treated wood samples were generated from a uniform stock of untreated southern yellow pine to minimize variability that can result from the treatment of different wood types. Eight 5-m (16-ft) lengths of 3.8 by 8.8 cm (1.5 by 3.5 in.) untreated dimensional lumber were purchased from a Miami, FL lumberyard. To reduce possible

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